
VOLUME 62 2002

Advancement of the breeding season in Coopworth ewes

J. F. SMITH AND L. T. McGOWAN
Ruakura Agriculture Centre
Ministry of Agriculture and Fisheries, Hamilton

T. W. KNIGHT

Batchelor Agriculture Centre
Ministry of Agriculture and Fisheries, Palmerston North

K. S. MACLEAN

Ministry of Agriculture and Fisheries, Gisborne

ABSTRACT

Mixed-age Coopworth ewes (280) were allocated to an experiment in which the effects of immunisation against androstenedione, synchronisation with progestagen sponges, and exposure to the ram effect, on oestrus and ovulation were examined. The observations were commenced at 2 different times (mid-January and early February) prior to the commencement of the normal breeding season and continued until all ewes had exhibited oestrus and ovulated.

Immunisation against androstenedione increased the ovulation rate (+0.60) at the ram-induced ovulation. However it suppressed the proportion of ewes exhibiting oestrus after sponge withdrawal at both times of ram introduction. Ewes isolated from the ram failed to ovulate and the first spontaneous ovulation was not recorded until 6 weeks after that recorded for ewes exposed to the ram effect. Pre-treatment with sponges was necessary for the ram-induced ovulation be be accompanied by oestrus. The extent of the ram effect was most noticable with 95% of ewes exposed to the ram ovulating in January.

Keywords Breeding season, ram effect, Coopworth, immunisation, synchronisation, oestrus, ovulation.

INTRODUCTION

Advancement of the onset of the breeding season using the ram effect has received renewed interest as a less expensive technique in the production of out-of-season lambs for the chilled meat trade. The ram effect is due at least in part to a pheromone produced by the ram (Knight and Lynch, 1980) and can be achieved with brief contract between the ewe and rams (Knight *et al.*, 1978). The normally silent ovulation induced by the rams can be converted to an overt oestrus if ewes are given progesterone prior to ram introduction (Cognie *et al.*, 1982).

The effect of ram introduction is to increase the level of luteinising hormone (LH) in the ewe. Ewes immunised against steroid antigens have shown similar LH responses to ram introduction even though their basal LH levels were already elevated. They also had a higher ovulation rate at the induced ovulation than did non-immunised ewes (Scaramuzzi *et al.*, 1981). Gibb *et al.* (1982) indicated that ewes previously immunised against androstenedione cycled earlier in the season than did non-immunised control ewes. Unpublished data from trials at Ruakura (J.F. Smith, pers. comm.) corroborates that finding.

Thus a combination of these techniques could have significant practical application in out-of-season lamb production. It was therefore considered necessary to examine them in detail.

MATERIALS AND METHODS

Animals

Mixed-age Coopworth ewes (280) were used in the trial and allocated to treatment groups on the basis of age and live weight at weaning.

Vasectomised Dorset Horn rams (12) were used to detect oestrus.

Design of Experiment

A modified factorial 2 x 2 x 2 x 2 (n = 20) design was used. Ewes were either immunised or not prior to treatment; pretreated with progestagen sponges or not; exposed to ram effect at 1 or 2 different times or kept isolated from rams. Ewes that were not pretreated with progestagen and kept isolated from rams acted as the untreated control group for both times of ram introduction.

Conduct of Trial

The timetable of events and design is illustrated in Table 1. Ewes were immunised with an androstenedione immunogen (Fecundin, Glaxo) at weaning in early December and received a booster injection 3 weeks later. Progestogen pretreatment was achieved by the insertion of intravaginal sponges containing 70 mg medroxy-progesterone-acetate for a period of 14 d. Sponges were removed at the time of introduction of the rams. Ram introduction occurred in 1 group in mid-

TABLE 1 Allocation of animals to groups and schedule of events.

Date	Treatment	Number of ewes													
		Immunised							Not immunised						
16 December	Immunisation 1	140							(140)						
6 January	Immunisation 2	140							(-)						
7 January	Sponge out Group 1	40		(No sponge)					40		(No sponge)				
	Rams in	20		20					20		20				
	No rams		20			40				20			40		
21 January	Sponge in Group 2							40							40
26 January	Laparoscopy 1	20	20	20		40			20	20	20		40		
4 February	Sponge out Group 2														
	Rams in				20		20					20		20	
	No rams					20		20					20		20
9 February	Laparoscopy 2	*	*	*	20	20	20	20	*	*	*	20	20	20	20
23 February	Laparoscopy 3	*	*	*	*	*	*	*	*	*	*	*	*	*	*
9 March	Laparoscopy 4	*	*	*	*	*	*	*	*	*	*	*	*	*	*
23 March	Laparoscopy 5	*	*	*	*	*	*	*	*	*	*	*	*	*	*

* Ewes that had not previously shown oestrus and ovulation.

mid-January and in another group 14 d later in early February.

All ewes were run as a single mob isolated from rams from weaning up to date of first ram introduction. The 80 ewes to be exposed to the ram effect were separated and confined to areas of 0.33 ha with 6 harnessed vasectomised rams. oestrus data were recorded daily for the first 5 d after ram introduction and thereafter 3 times weekly. Ewes were examined for ovulation via laparoscopy 5 d after each of the ram introductions and thereafter at intervals of 14 d.

Exposure to rams increased ovulation rate with an increase in the proportion of ewes having higher order multiple ovulations at time of first ovulation ($P < 0.05$). The ovulation rate at first combined oestrus and ovulation was influenced by the time of ram introduction ($P < 0.05$) with the ewes in the latter treated group having a higher proportion of twin ovulations.

Ewes remained in the isolated groups until an ovulation was observed whereupon they were placed into the ram group and examinations continued until they had exhibited an oestrus accompanied by an ovulation. Once any ewe had exhibited oestrus and ovulation she was not examined further and was retired from the trial. All ewes both isolated and with rams were grazed on ryegrass (*Lolium* spp.) -white clover (*Trifolium repens*) pasture at an allowance of 2.0 kg green DM/d throughout the trial. Blood samples for antibody titre determination were collected from the immunised ewes at the time of laparoscopy.

Location of Trial

The experiment was conducted during 1982-83 at Ruakura Animal Research Station, Hamilton, NZ (latitude 37° 46' S; longitude 175° 20' E, elevation 40 m).

Statistical Analyses

Data on the period in which the first oestrus and/or ovulation was recorded and the ovulation rate at these times were subjected to χ^2 analyses. Ewe live weights at the different periods of laparoscopy and the liveweight gain from weaning were examined by analysis of variance.

Treatment effects on the lambing performance following a natural mating of all ewes in April were determined by χ^2 analyses.

TABLE 2 Percentage of ewes having their first ovulation at various times after treatment.

Treatment	No. of ewes	Date of laparoscopy			
		26 Jan.	9 Feb.	23 Feb.	9 Mar[1]
Rams early	80	85	13	1	1
Rams late	80	-	97	3	0
No ram	120	3	7	55	35

[1] Combined value for 9 March and 23 March.

TABLE 3 Effect of treatment on the distribution of ewes exhibiting oestrus in various periods after treatment (% of ewes treated).

Treatment	No. of ewe	Period ending 26 January	9 February	23 February	9 March	23 March	Not oestrus[1]
Immunised	140	3.7	11.6	19.5	28.3	27.2	9.7
Not immunised	140	10.8	15.2	17.8	25.5	22.5	8.2
Early	120	16.6	5.9	33.0	20.8	19.2	4.3
Late	120	-	26.7	10.3	29.6	25.0	8.5
Sponge + ram	80	25.0	42.5	12.5	11.2	5.0	3.7
Ram	80	0.0	6.4	49.6	34.6	1.3	7.8
Sponge only	80	0.0	0.0	2.5	30.0	60.0	7.5
Control	40	0.0	0.0	2.7	35.9	40.8	20.6

[1] Ewes not oestrus by time of 5th laparoscopy on 23 March.

TABLE 4 Percentage of ewes ovulating and exhibiting oestrus in the 5 d following ram introduction on either 26 January or 9 February.

Treatment		26 January Ovulated	26 January Oestrus	9 February Ovulated	9 February Oestrus
Ram	Sponge	88	50[1]	95	75[2]
Ram	No sponge	82	0	98	5
No ram	Sponge	3	0	10	0
No ram	No sponge	3	0	5	0

Date of ram introduction

[1] Immunised ewes = 25% and non-immunised = 75% on 26 January.
[2] Immunised = 55% and non-immunised = 95% on 9 February.

TABLE 5 Mean date (±SE) of first oestrus and ovulation for the various treatment groups and their ovulation rate.

Treatment	Mean date of first oestrus	Ovulation rate
Immunised		
Sponge early ram[1]	**9 Feb** ± 2.6	2.16 ± 0.22
Sponge early no ram	10 Mar ± 1.8	2.00 ± 0.17
Sponge late ram	19 Feb ± 3.6	2.11 ± 0.17
Sponge late no ram	12 Mar ± 1.5	2.00 ± 0.12
No sponge ram early	18 Feb ± 1.5	1.85 ± 0.15
No sponge ram late	26 Feb ± 1.9	2.06 ± 0.17
Control (no sponge - no ram)	11 Mar ± 1.2	1.82 ± 0.13
Non-Immunised		
Sponge early ram	1 Feb ± 3.4	1.30 ± 0.11
Sponge early no ram	13 Mar ± 1.5	1.26 ± 0.10
Sponge late ram	7 Feb ± 0.1	1.68 ± 0.15
Sponge late no ram	10 Mar ± 1.8	1.63 ± 0.11
No sponge ram early	17 Feb ± 1.6	1.53 ± 0.24
No sponge ram late	24 Feb ± 1.4	1.42 ± 0.14
Control (no sponge - no ram)	9 Mar ± 2.1	1.43 ± 0.14

[1] Early - Treated 21 January; Late -Treated 4 February.

RESULTS

Onset of Ovulation and Oestrus

The mean period of first ovulation was influenced by the presence or absence of rams ($P < 0.001$) and by the time of ram introduction ($P < 0.001$; Table 2). There were no effects of immunisation or of progestagen treatment. However immunisation delayed the time of onset of first oestrus ($P < 0.001$) and in addition to effects of time of treatment ($P < 0.001$) and an interaction between progestagen treatment and the presence of rams ($P<0.01$; Table 3).

The exposure to rams induced an earlier ovulation in ewes at both times of introduction, compared to the ewes isolated from the ram. Fifty seven percent of these ovulations were accompanied by oestrus if the exposed ewes had been pre-treated with progestagen. Immunisation treatment inhibited the expression of this oestrus in the ram effected-progestagen primed ewes (Table 4). These effects are reflected in the mean date of first oestrus and illustrated in Table 5.

Ovulation Rate

The ovulation rate at the first ovulation detected and at the first combined oestrus and ovulation was influenced by immunisation treatment ($P < 0.001$; Table 6). Immunisation substantially increased the proportion of ewes having twins or higher order multiple ovulations at the time of first ovulation. At the time of first combined oestrus and ovulation immunisation increased the proportion of twin ovulating ewes only.

Exposure to rams increased ovulation rate with an increase in the proportion of ewes having higher order multiple ovulations at time of first ovulation ($P<0.05$). The ovulation rate at first combined oestrus and ovulation was influenced by the time of ram introduction ($P<0.05$) with the ewes in the latter treated group having a higher proportion of twin ovulations.

TABLE 6 Effect of treatment on the distribution of ewes with different numbers of ovulations at any time of first combined oestrus and ovulations (% of ewes treated).

Treatment	No of ewes	No. of ovulations 1	2	3+[1]	Ovulation rate
Time of first ovulation					
Immunised	140	21	51	28	2.10
Not-immunised	140	55	39	6	1.51
Rams	160	32	45	23	1.92
No ram	120	47	43	10	1.66
Time of first combined oestrus and ovulation					
Immunised	140	21	61	18	2.00
Not-immunised	140	58	39	3	1.46
Early	120	47	41	11	1.64
Late	120	32	56	12	1.82

[1] Combined for 3 to 5 ovulations.

TABLE 7 Overall mean (± SE) live weight and liveweight gain.

Date	Live weight (kg)	Gain from 17 December 1982 (kg)
17 December 1982	53.7 ± 0.4	-
21 January 1983	54.9 ± 0.5	1.2 ± 0.1
23 February 1983	54.1 ± 0.5	0.5 ± 0.2
23 March 1983	55.2 ± 0.8	1.5 ± 0.3

Live Weight

The mean live weight at the commencement of the trial and at subsequent laparoscopy and the mean liveweight gain from commencement to laparoscopy are presented in Table 7.

Liveweight gain from commencement of trial (17 December) to first laparoscopy was influenced by immunisation ($P < 0.001$) with the immunised ewes showing a lower gain (0.75 ± 0.02 kg) than the non-immunised ewes (1.63 ± 0.03 kg). The liveweight gain from commencement to the third laparoscopy on 23 February showed effects of immunisation ($P < 0.001$; immunised $= 0.13 \pm 0.10$ *v.* non-immunised $= 0.84 \pm 0.10$ kg) as well as time of treatment ($P<0.001$; early $= 0.15 \pm 0.09$ *v.* late $= 0.58 \pm 0.12$), presence of rams ($P<0.001$; rams $= -0.51 \pm 0.06$ *v.* no rams $= 1.29 \pm 0.06$); pretreatment with progestagen ($P < 0.001$; sponges $= 0.74 \pm 0.10$ *v.* no sponges $= 0.23 \pm 0.11$) as well as interactions between these factors.

Effect on Lambing to a Subsequent Mating in April.

There were no significant effects of any treatment on the number of lambs born or weaned.

DISCUSSION

Exposure of Coopworth ewes to the ram effect induced ovulation and advanced the breeding season. This is confirmatory of many earlier reports of a similar effect in Romney ewes about the same location (Edgar and Bilkey, 1963; Tervit *et al.*, 1977; Knight *et al.*, 1978; Knight, 1985). However the response obtained in the present experiment with similar treatment (+ rams, no sponges) was at least 3 weeks earlier than that previously reported. This may reflect the earlier onset of the normal breeding season in Coopworths as compared to Romneys (Kelly *et al.*, 1976). However the variation in response between years shown by Tervit *et al.* (1977) must be recognised. A repeat of early ram introduction following progestagen pre-treatment on the same ewes used in the present trial at the same dates in the following year showed a much poorer and later response (Smith *et al.*, 1987). One possible cause for this annual variation could be the extent of cloud cover in the months preceeding treatment.

The pre-treatment of ewes with progestagen sponges 14 d prior to ram introduction advanced the onset of oestrus by almost 1 cycle. This is consistent with the findings of Cognie *et al.* (1982) and the need for progesterone priming for the expression of oestrus behaviour in the ewe (Robinson, 1954).

Immunisation against androstenedione did not interfere with the ram induced ovulation and this is consistent with findings of Martin *et al.* (1981). However contrary to the findings of Martin *et al.* (1981) immunisation reduced the number of ewes exhibiting oestrus and this may be related to time of treatment after booster injection (Smith, 1985). Androstenedione immunisation itself did not advance the onset of the breeding season and this is in contrast to that reported by Gibb *et al.* (1982).

The increase in ovulation rate seen at the induced ovulation in the immunised ewes is consistent with previous reports (Scaramuzzi *et al.*, 1981; Martin *et al.*, 1981; Davis *et al.*, 1985; Smith *et al.*, 1987). The increase in ovulation due to the introduction of rams is consistent with the findings reported by other workers (Knight, 1983; Martin *et al.*, 1986). This response cannot be attributed to nutritional effects over time as suggested by Martin *et al.* (1986) because the ewes exposed to rams showed a lower rate of liveweight gain over the experimental period. It is most likely to be due to an effect on follicle stimulating hormone (FSH) levels although no differences in FSH levels has yet been reported. The effect of time of ram introduction on ovulation rate may however be a reflection of a nutritional effect as the later treated ewes showed a greater liveweight gain.

CONCLUSION

The combination of progesterone pre-treatment with early introduction of rams enables the maximum advancement of the breeding season to be obtained from the ram effect.

The coupling of these treatments to the immunisation of ewes against androstenedione could lead to increased lambing performance in ewes mated out-of-season. However the immunisation treatment would need to proceed ram introduction by at least 4 weeks.

ACKNOWLEDGEMENTS

To staff of the Sheep Unit, Ruakura for the management of stock, assistance with laparoscopy and collection and collation of records. To D. Duganzich for biometrical analyses.

REFERENCES

Cognie Y.; Gray S.J.; Lindsay D.; Oldham C.M.; Pearce D.T.; Signoret J.P. 1982. A new approach to controlled breeding in sheep using the 'ram effect'. *Proceedings of the Australian Society of Animal Production* **14**: 519-522.

Davis G.H.; Crosbie S.F.; Smith J.F. 1985 Effects of season of steroid immunisation and Booroola genotype on the level and duration of response in ovulation rate of ewes. In J.F. Smith — *Steroid immunisation of ewes to increase lambing. Proceedings of the New Zealand Society of Animal Production* **45**: 178-180

Edgar D.G.; Bilkey D.A. 1963. The influence of rams on the onset of the breeding season in ewes. *Proceedings of the New Zealand Society of Animal Production* **23**: 79-87

Gibb M.; Hudson N.; Kieboom L.; McNatty K.P. 1982. Long-term active immunisation of Romney ewes with an androstenedione-protein conjugate - effects on oestrus, ovulation and lambing. *New Zealand journal of experimental agriculture* **10**: 125-128.

Kelly R.W.; Allison A.J.; Shackell G.H. 1976. Seasonal variation in oestrus and ovarian activity of five breeds of ewes in Otago. *New Zealand journal of experimental agriculture* **4**: 209-214.

Knight T.W. 1983. Ram induced stimulation of ovarian and oestrus activity in anoestrus ewes - a review. *Proceedings of New Zealand Society of Animal Production* **43**: 7- 11.

Knight T.W. 1985. Are rams necessary for the stimulation of anoestrous ewes with oestrous ewes? *Proceedings of the New Zealand Society of Animal Production* **45**: 49-50.

Knight T.W.; Lynch P.R. 1980. Source of ram pheromones that stimulate ovulation in the ewe. *Animal reproduction science* **3**: 133-136.

Knight T.W.; Peterson A.J.; Payne E. 1978. The ovarian and hormonal responses of the ewe to stimulation by the ram early in the breeding season. *Theriogenology* **10**: 343- 348.

Martin G.B.; Oldham C.M.; Cognie Y.; Pearce D.T. 1986. The physiological responses of anovulatory ewes to the introduction of rams - a review. *Livestock production science* **15**: 219-247.

Martin G.B.; Scaramuzzi R.J.; Lindsay D.R. 1981. Induction of ovulation in seasonally anovular ewes by the introduction of rams. Effects of progesterone and active immunisation against androstenedione. *Australian journal of biological sciences* **34**: 459-575.

Robinson T.J. 1954. Relationship of oestrogen and progesterone in oestrous behaviour of the ewe. *Nature, London* **173**: 878.

Scaramuzzi R.J.; Hoskinson R.M.; Hinks N.T.; Radford H.M.; Turnball K.E. 1981. Ram-induced ovulation in seasonally anovular Merino ewes actively immunised against on oestrone-gelatin conjugate. *Proceedings of the Australian Society of Reproductive Biology* **13**: 21.

Smith J.F. 1985. Immunisation of ewes against steroids: a review. In *Steroid immunisation of ewes to increase lambing. Proceedings of the New Zealand Society of Animal Production* **45**: 171-177.

Smith J.F.; McGowan L.T.; Maclean K.S.; Farquhar P.A. 1987. The effect of steroid immunisation on the seasonal pattern of oestrus, ovulation and ovulation rate in Coopworth ewes. *Proceedings of the New Zealand Society of Animal Production* **47**: 143-146.

Tervit H.R.; Havik P.G.; Smith J.F. 1977. Effect of breed of ram on the onset of the breeding season in Romney ewes. *Proceedings of the New Zealand Society of Animal Production* **37**: 142-148.